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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/536,706	01/03/2006	Stewart E. Hooper	YAMAP0983US	9271

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EXAMINER	
MALEKZADEH, SEYED MASOUD	

ART UNIT	PAPER NUMBER
1791	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/536,706	HOOPER ET AL.	
	Examiner	Art Unit	
	SEYED M. MALEKZADEH	1791	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 October 2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-6,11 and 13-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-6, 11, nad 13-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

Claims 1-6, 11, 13-20 are pending.

Claims 7-10, 12, and 21-23 are cancelled.

Claim 1 is amended.

In view of the amendment, filed on 10/07/2008, following rejections are **withdrawn** from the previous office action mailed on 07/09/2008 for the reason of the record.

- Rejection of claims 1-6 and 8-18 under 35 U.S.C. 103(a) as being unpatentable over Barnes et al (US 2004/0214412) in view of Van Suchtelen et al. (US 4,916,089)
- Rejection of claims 19-20 under 35 U.S.C. 103(a) as being unpatentable over Barnes et al (US '412) in view of Van Suchtelen et al. (US '089), and further in view of Hooper et al. (US 2002/0117103)

New Grounds of Rejection

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-6, 11, and 13-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Barnes et al (US 2004/0214412) in view of Mayer et al. (Journal of Crystal Growth 201/202 (1999) 318-322), the prior art submitted by the applicant on 06/23/2005.

Barnes et al ('412) teaches a method of growing a P-type nitride semiconductor material having magnesium as a p-type dopant by molecular beam epitaxy (MBE), comprising supplying ammonia gas, gallium and magnesium to an MBE growth chamber containing a substrate so as to grow a p-type nitride semiconductor material over the substrate. (See abstract)

Furthermore, the prior art teaches the grown nitride layer is a p-type GaN layer; however, it is not limited to the growth of p-type GaN layer. (See paragraph [0032]) Moreover, in one embodiment, Barnes et al ('412) teaches the first grown layer is a p-typed doped GaN layer and one or more other (Al,Ga,In)N layers would be grown after the completion

step of growing the p-type doped GaN layer. (See paragraph [0052]) therefore, prior art clearly teaches the process of producing a p-type (Ga, Al) N by the MBE process.

Furthermore, Barnes et al ('412) discloses during the epitaxial growth process, ammonia or another nitrogen precursor is supplied to the MBE chamber by means of a supply conduit providing gallium and, possibly, indium and/or aluminium and/or a dopant species from the appropriate sources into the MBE chamber. (See paragraph [0005])

Moreover, the prior art discloses Magnesium is supplied to the growth chamber at a beam equivalent pressure of at least $1\times10^{-9}mbar$, and preferably in the range from $1\times10^{-9}mbar$ to $1\times10^{-7}mbar$ during the growth process. This provides p-type GaN that has a high concentration of free charge carriers and eliminates the need to activate the magnesium dopant atoms by annealing or irradiating the material. Therefore, as to claims 13-16, Barnes et al ('412) clearly teaches supplying magnesium source at a beam equivalent pressure of $1\times10^{-9}mbar$

Furthermore, prior art teaches supplying magnesium at a beam equivalent pressure of $1\times10^{-7}mbar$ would result in a high rate of consumption for the magnesium source material. However, it is preferable to supply the magnesium at a beam equivalent pressure significantly below $1\times10^{-7}mbar$, to reduce the consumption of magnesium source material. (See paragraph [0044]) Therefore, the prior art teaches

changing the supply rate of magnesium during the growth of the nitride layer.

Moreover, Barnes et al ('412) discloses gallium for the MBE growth process is supplied by a beam of elemental gallium having a beam equivalent pressure in the range of $1\times10^{-8} mbar$ to $1\times10^{-5} mbar$. Therefore, as to claims 17-18, Barnes et al ('412) teach supplying elemental gallium at a beam equivalent pressure of at least $1\times10^{-8} mbar$ or below $1\times10^{-5} mbar$.

Furthermore, Barnes et al ('412) teach the substrate is heated to a desired temperature for MBE growth. The substrate temperature during the growth process is preferably at least 850° C. and at the most 1050° C (See paragraph [0035]). However, the prior art is silent about the temperature which growth process is carried out, but it would have been obvious that the substrate temperature is a function of the growth process temperature and therefore the reference discloses the growth process is carried out at a temperature of at least 800° C and at the most 1050° C and further according to the prior art, the growth process is implemented preferably at least 850° C and particularly at least 940° C in which this range of temperature which is disclosed by the prior art clearly overlaps the claimed subject matter of a process temperature within 920° C to 960° C and a temperature of at least 950° C.

The prior art, however, fails to teach that the magnesium source which is supplied to the process chamber is bis (cyclopentadienyl)

magnesium (CP_2Mg), and further reducing the carbon contamination caused by (CP_2Mg) in the semiconductor material through implementing the growth process at a temperature from 920° C to 960° C.

In the analogous art, Mayer et al. teach a method of manufacturing of GaN-based optoelectronic devices by epitaxial growing of GaN films on an inert- and active-side GaN bulk substrate using reactive MBE, where ammonia is cracked on the substrate surface. (See abstract and lines 1-4 of introduction) Further, prior art teaches MCP_2Mg is used as a p-doping source during reactive MBE process in which through using a gaseous precursor we achieve an excellent controllability and stability of the P-doping (See lines 1-5 of the section 4). Moreover, Mayer et al. also teach the intensity of all bound excitations decreases with increasing temperature. The free excitations dominate the spectra at temperatures above 29 K and at about 80 K even the free excitation C (carbon) becomes visible (see page 320, right column, lines 5-10) in which this means by increasing the temperature of the growth process the carbon contamination significantly decreases in the semiconductor material, wherein the increased temperature can fall within a temperature from 920° C to 960° C as suggested by Barnes et al ('412)

Therefore, **it would have been obvious** for one ordinary skill in the art at the time of applicant's invention to modify the teachings of Barnes et al ('412) through providing bis(cyclopentadienyl) magnesium

(CP_2Mg) because bis(cyclopentadienyl)magnesium (CP_2Mg) has a capability of complete dissociation in the MBE chamber for P-type doping of the semiconductor layer in the MBE chamber, and further implementing the growth process at an increased temperature which reduces the carbon contamination caused by (CP_2Mg) in the semiconductor material in order to decrease all bound excitations in which this effect result in reducing the segregation of impurities and dopants at dislocations and the formation of cracks in AlGaN layers during device operation, as suggested by Mayer et al.

Claims 19-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over combined teachings of Barnes et al ('412) in view of Mayer et al, as applied to claims 1-6, 11, and 13-18, and further in view of Hooper et al. (US 2002/0117103)

Combined teachings of Barnes et al ('412) and Mayer et al teach all the process limitations of a method for growing a P-type nitride semiconductor material as discussed above in rejection of claims 1-6, 11, and 13-18. Furthermore, Indium and Aluminum have a functional equivalency as a dopant for the GaN layer in the production (Al,Ga,In)N layers. As discussed above, Barnes et al ('412) teaches gallium for the MBE growth process is supplied by a beam of elemental gallium having a beam equivalent pressure in the range of $1\times10^{-8}mbar$ to$1\times10^{-5}mbar$. However, the combined teachings of Barnes et al ('412) and Mayer et al

fail to teach the degree of overall beam equivalent pressure supplying gallium and aluminum is between at least $1\times10^{-8}mbar$ to $1\times10^{-5}mbar$ or below.

In the analogous art, Hooper et al (2002/0117103) teaches a method of growing an (In, Ga)N layer structure by molecular beam epitaxy. Hooper et al ('103) further teaches the beam equivalent pressure of indium and gallium supplied to the growth chamber may be equal to or greater than $1\times10^{-8}mbar$ and less than $1\times10^{-4}mbar$. (See paragraphs [0027] and [0028])

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify the combined teachings of Barnes et al ('412) and Mayer et al by providing a supplying pressure of more than $1\times10^{-8}mbar$ for gallium and aluminum during (Ga,Al)N growth process in order to prevent from low growth rate of nitride layer and obtaining a high-quality growth of the layers, as suggested by Hooper et al. ('103).

Response to Arguments

Applicant's arguments with respect to claims 1-6, 11, and 13-20 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Seyed Masoud Malekzadeh whose telephone number is 571-272-6215. The examiner can normally be reached on Monday – Friday at 8:30 am – 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Steven P. Griffin, can be reached on (571) 272-1189. The fax number for the organization where this application or proceeding is assigned is 571-272-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published application may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance form a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SEYED M. MALEKZADEH/

Patent Examiner

Art Unit 1791

/Steven P. Griffin/

Supervisory Patent Examiner, Art Unit 1791